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Utjecaj različitih profilaktičkih pasta i vremena čišćenja na DIAGNOdent/DIAGNOdent pen-vrijednosti

Influence of Different Prophylactic Pastes and Cleaning Methods on DIAGNOdent/ DIAGNOdent Pen Readings Values

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Sažetak

Svrha: Svrha rada bila je analizirati utjecaj uporabe različitih profilaktičkih pasta na vrijednosti očitanja DIAGNOdent/DIAGNOdent-penom (DD/DD pen) i utjecaj različitih vremena i tehnika ispiranja ostataka pasta na očitanje DD/DD pen-vrijednosti. Također je trebalo ustanoviti postoje li razlike u očitanju vrijednosti između DD i DD pen-uređaja. **Materijal i postupci:** Na 35 zdravih trajnih trećih molara DD/DD pen-uređajima izmjerene su referentne vrijednosti te su odabrani zubi čije vrijednosti nisu prelazile 5. Ispitivalo se sedam različitih pasta za profilaktičko čišćenje (DentsplyNupro Medium, Voco Klint, Vivadent Proxyt RDA 7, Vivadent Proxyt RDA 83, Vivadent Proxyt RDA 36, Dentsply Zircate Prophy, Septodont Detartrine) i njihov utjecaj na DD/DD pen-referentne vrijednosti. Ispitivala su se i četiri načina ispiranja paste iz fisura: voda 5 sekundi, voda 10 sekundi, voda+zrak 5 sekundi i voda+zrak 10 sekundi. **Rezultati:** Pasta Dentsply Nupro imala je statistički znatno povećanje vrijednosti - od 4,34 do 8,94 za DD uređaj te 5,48 do 9,71 za DD pen-uređaj ($p< 0,05$), a ostale nisu pokazivale veće povećanje. **Zaključak:** Nije dokazana statistička razlika između metoda ispiranja ostataka profilaktičkih pasta iz fisura. Nakon korištenja bilo kojeg načina ispiranja, male količine paste ostaju u fisuri i utječu na DD/DD pen -vrijednosti. Zabilježene su statistički znatne razlike između referentnih vrijednosti i načina ispiranja paste vodom 5 sekundi za uređaje DD i DD pen ($p=0,034$). U očitanju ostalih vrijednosti nije bilo statistički znatnih razlika između DD i DD pen-uređaja ($p>0,05$).

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Uvod

Analiza okluzalne fisure i detekcija karijesa u njoj, obično je vrlo teška u odnosu prema glatkim površinama te se analizira uglavnom konvencionalno - vizualnom i taktilnom percepcijom i rentgenskim snimkama. U konvencionalnoj detekci-

Introduction

Detection of caries in occlusal fissures is usualy more difficult than on smooth surfaces, so the analysis is usually conventional, by visual and tactile perception and intra-oral radiographs. By conventional methods, caries is detectable if the white-spot

ji karijesa utvrđuje se da postoji ako se vidi bijela lezija, ako sonda zapinje ili je uočljiva kavitacija, što su zapravo subjektivne interpretacije koje mogu i ne moraju biti točne i objektivne te se mogu razlikovati od ispitivača do ispitivača. Stomatološka sonda često može oštetiti caklinu iznad potpovršinske karijesne lezije te se kariogena flora inficiranih mjesta može prenijeti na druga područja, što rezultira progresijom karijesne lezije i njezinim širenjem (1).

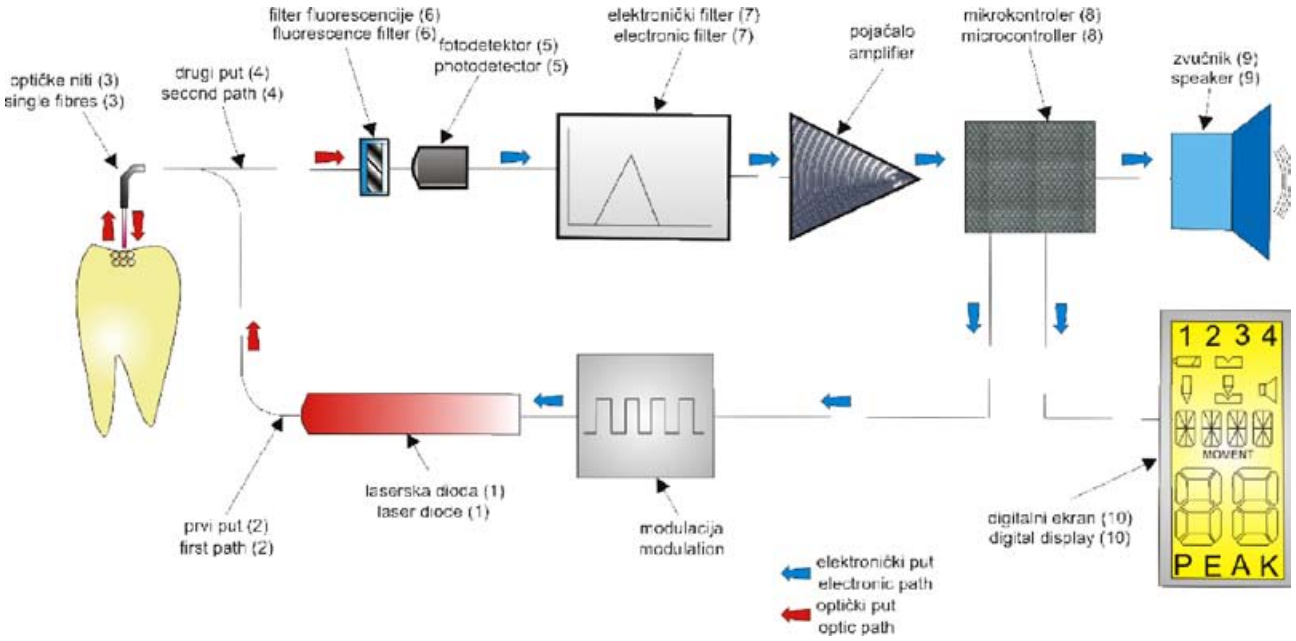
Godine 1998. proizveden je uređaj za detekciju karijesa okluzalne plohe DIAGNOdent (KaVo, Biberach, Germany), a 2005. izrađena je poboljšana verzija koja omogućuje analizu i aproksimalne površine DIAGNOdent pena (KaVo, Biberach, Germany). Uređaji rade na načelu fluorescencije zubnih tkiva, što znači da ona u svojem sastavu ima molekule koje apsorbiraju energiju laserske zrake te reemitiraju svjetlost druge valne duljine. Bakterije u karijesnoj leziji i njihovi produkti, kao što su porfirini, posebice uroporfirin, koproporfirin i protoporfirin IX., indentificirane su kao molekule sa sposobnošću fluorescencije i nalaze se u većini oralnih bakterija (2).

Princip rada DIAGNOdent/DIAGNOdent penuređaja je isti, a prikazan je na Slici 1. Izvor svjetlosti je laserska dioda (1) od 655 nm valne duljine. Prvi optički put služi za prijenos svjetla kroz

lesion is observed, if a probe 'sticks' or the cavitation is present, which are in fact personal interpretations which could or could not be true and objective, and can differ from one examiner to another. Often probing may damage the enamel over subsurface caries lesion which may lead to transmission of cariogenic flora of infected places to other areas, which results in progression of caries lesion and its expansion (1).

In the year 1998, the DIAGNOdent (KaVo, Biberach, Germany), a device for detection of caries of occlusal surface was introduced, and in the year 2005 the improved version, the DIAGNOdent pen (KaVo, Biberach, Germany), which enables also the analysis of approximal surface was introduced. The devices work on the principle of fluorescence of tooth tissues, which means that the tooth substances consist of molecules that absorb the energy of laser and re-emit the light of another wavelength. Bacteria in caries lesion with their products such as porfyrine, especially uroporphyrine, coporphyrine and protoporphyrine IX have been identified as molecules with the ability of fluorescence and they are to be found in most of the oral bacteria (2).

The mode of work of DIAGNOdent/DIAGNOdent pen device is the same, and it is shown in Figure 1. A laser diode (1) of 655 nm wavelength serves as the light source. The first optical path (2) serves



Slika 1. Princip rada DIAGNOdent/DIAGNOdent pen uređaja ("preuzeto iz Journal of Dentistry, 34, Lussi A, Hellwig E, Performance of a new laser fluorescence device for the detection of occlusal caries in vitro, 467-471, 2006, s dopuštenjem od Elsevier")

Figure 1 Principles of DIAGNOdent/DIAGNOdent pen devices ("reprinted from Journal of Dentistry, 34, Lussi A, Hellwig E, Performance of a new laser fluorescence device for the detection of occlusal caries in vitro, 467-471, 2006, with permission from Elsevier")

optičke niti do analizirane površine na zubu (2,3). Drugi optički put transferira fluorescenciju do fotodetektora (4,5), gdje se odvaja fluorescirana zraka od ekscitacijske i reflektirane zrake uz pomoć filtra fluorescencije (6). Svjetlo iz okoline također je eliminirano elektroničkim filtrom s posebnim svojstvima (7). Cijeli se proces nadzire mikrokontrolerom (8) spojenim sa zvučnicima (9) i digitalnim zaslonom (10) koji pokazuje trenutnu i najveću vrijednost. Razlika između DIAGNOdent (DD) i DIAGNOdent pena (DD pen) jest u tome što DD uređaj ima jednu optičku nit koja služi za ekscitaciju i snop od devet koncentričnih niti oko nje za detekciju. DD pen-uređaj ima cilindričnu i koničnu sondu za mjerenje, s promjerima na vrhu od 1,1. i 0,7 mm. Sonda služi i za ekscitaciju i za detekciju fluorescentne zrake, za razliku od DD uređaja u kojem postoje različiti snopovi za ekscitaciju i detekciju (3). DD pen uređaj također može analizirati aproksimalne plohe, tako što s posebnim nastavkom okreće lasersku zraku za 100° omogućujući analizu aproksimalnih mjesta.

Mnogi čimbenici mogu ometati DD/DD pen-vrijednosti i dovesti do pogrešnih tumačenja rezultata i pogrešne terapije. Ponajprije su to ostaci dentobakterijskog plaka, kamenca i pigmenata (4-12), egzogenih tvari u hrani (13), paste za poliranje i pranje zuba (14,15) te dentalni materijali (6,16,17). Stupanj hidratacije zuba također utječe na izmjerene vrijednosti (4, 5, 8, 9, 11, 18-24).

Svrha rada bila je analizirati utjecaj uporabe različitih profilaktičkih pasta u stomatološkoj praksi na vrijednosti očitanja DIAGNOdent/DIAGNOdent pena te utjecaj različitih vremena i tehnika ispiranja ostataka profilaktičkih pasta na očitanje DIAGNOdent/DIAGNOdent pen-vrijednosti.

Materijali i postupci

Prikupljeno je 35 ekstrahiranih trećih molara bez karijesa okluzalne plohe. Utvrđeno je to detaljnim pregledom uz pomoć stomatološke sonde i zrcala te korištenjem kirurškoga binokularnog povećala s povećanjem od 2,5 puta. Zubi nisu bili stariji od tri mjeseca i bili su pohranjeni u jednopostotnoj otopini kloramina. Molare su pregledavala dva iskusna doktora stomatologije. Nakon toga, temeljito su ih očistili četkicom No.9654 (Komet Brasseler, Lemgo, Germany) na mikromotoru s vodenim hlađenjem 20 sekundi. Zatim su zube ispirali vodom 10 sekundi iz pustera sa stomatološkog stolca Sirona C8+ (Sirona Dental Systems GmbH, Bensheim,

to transmit the light through the optical fibers (3) to the analyzed surface of the tooth. Second optical path (4) transfers the fluorescence to the photo detector (5) where separation of the fluorescence light from the excitation and reflected light is accomplished with a fluorescence filter (6). Ambient light is eliminated by an electronic filter (7) with specific characteristics. The whole process is controlled by a microcontroller (8) with connection to the speaker (9) and the digital display (10) showing the real and peak value. The difference between DIAGNOdent (DD) and DIAGNOdent pen (DD pen) is that DD device has one optical fiber for excitation and a bundle of nine concentrically arranged fibers around it which serve for detection. The DD pen has a cylindrical and a conical probe for measurement, with diameters of 1.1 and 0.7 mm at the tip. The probe is for excitation and detection of fluorescent light, unlike the DD device where there are different bundles for excitation and detection (3). Also, the DD pen device can analyze approximal surfaces because of its special tip, which deflects the laser light for 100° enabling the analysis of approximal surfaces.

Many factors can obstruct DD/DD pen values and result in false interpretation of the results and false therapy. These factors, prior to all, are residues of dentobacterial plaque, calculus and stains (4-12), exogenic agents in food (13), polishing pastes and toothpastes (14, 15), dental materials (6,16,17). The degree of hydration of teeth also has an impact on measured values (4, 5, 8, 9, 11, 18 -24).

The aim of this study was to analyze the influence of different prophylactic pastes used in dental practice on reading values of DIAGNOdent/DIAGNOdent pen and an influence of different times and cleaning methods of prophylactic pastes residues on DIAGNOdent/DIAGNOdent pen reading values.

Materials and methods

35 extracted third molars which showed an absence of occlusal surface caries were gathered. This was established by detailed inspection using a dental probe and a mirror with help of magnifier binocular loupe with magnification of 2.5 X. Teeth were not older than three months and were stored in 1% solution of chloramin. Molars were inspected by two experienced dentists. Afterwards, molars were thoroughly cleaned with bristle brush No.9654 (Komet Brasseler, Lemgo, Germany) on rotating contra-angle with water cooling for 20 seconds. After that, the teeth were rinsed with water for 10 seconds from 3 in 1 syringe in dental unit Sirona C8+ (Sirona Den-

Njemačka) i dvije sekunde sušili zrakom iz pustera sa stomatološkog stolca C8+. KaVo DD/DD pen-uređaji koristili su se za analizu okluzalne plohe i postavljanje referentnih vrijednosti.

Osim DD uređaja koristio se nastavak tipa A, a uz DD pen priloženi stakleni nastavak za analizu okluzalnih ploha. Prije svakog mjerenja DD nastavak je očišćen 70-postotnim etanolom i kalibriran priloženim standardnim keramičkim uzorkom. Pregledavala se okluzalna ploha uređajima DD i DD pen te su se bilježile vrijednosti. Prihvaćali su se samo zubi čije okluzalne plohe imaju najveću registriranu vrijednost do 5, što upućuje na zdravu caklinu koja se obično histološki označava s D_0 (3). Mjerenja i očitanja DD/DD pena obavljala su dva doktora stomatologije, kako bi se lakše uskladila stajališta i pogreške svele na najmanju mjeru. Zubi su bili obilježeni vodootpornim flomasterom rednim brojevima od 1 do 35.

Vrijednosti koje su se dobile tim očitanjem predstavljale su referentne vrijednosti(RV) za DD/DD pen.

Nakon toga odabrano je sedam komercijalnih pasta za profilaktičko čišćenje u stomatologiji za analizu DD/DD pen-uređajem. Na staklenoj pločici za miješanje bile su pripremljene male količine različitih pasta i to iz srednjeg dijela pakiranja te postavljene zasebno, tako da su bile međusobno odvojene. Zatim se svaka pasta analizirala DD/DD pen-uređajem tako da se nastavak prislonio na srednji dio paste te je obavljeno pet mjerenja za svaku. Između mjerenja, DD/DD pen nastavci su se čistili 70-postotnim etilnim alkoholom.

Zdravi molari čistili su se deset sekundi pojedinim pastama uz pomoć mikromotora s malim brojem okretaja, bez vode sa stomatološkog stolca C8+ i četkicom No.9645 (Komet Brasseler, Lemgo, Njemačka). Za svaku pastu za čišćenje uzimala se posebna četkica, kako se ne bi pomiješali ostaci različitih pasta na četkicama. Nakon toga slijedilo je čišćenje zuba različitim metodama i različitog trajanja, kako je opisano u tablici 1. U različitim metodama ispiranja pasta sa zuba koristio se stomatološki puster sa stomatološke stolice Sirona C8+, jer ima kombinaciju vode, zraka i spreja. Udaljenost pustera od površine zuba je bila 2 mm. Nakon ispiranja ostataka paste, zubi su se sušili dvije sekunde zrakom iz pustera. Analiza fisura provodila se DD/DD pen-uređajima te se bilježila najveća vrijednost za pojedini zub.

Nakon svakog čišćenja različitom pastom i očitanja vrijednosti DD/DD pen-uređajem, bilo je potal Systems GmbH, Bensheim, Germany) and dried with air from 3 in 1 syringe in dental unit Sirona C8+ for 2 seconds. KaVo DD/DD pen devices were used for the analysis of occlusal surface and setting of the reference values.

With DD device tip A was used, and with DD pen provided glass tip for the analysis of occlusal surfaces was used. Before each measurement, the DD tip was cleaned with 70% ethanol and calibrated with provided ceramic standard. The occlusal surface was measured with DD and DD pen, and those values were noted down. Only teeth with registered highest value up to 5 were selected for the study, indicating healthy enamel, histologically marked with D_o (3). Measurements and readings of DD/DD pen were carried out by two dentists to reduce errors to the minimum. Teeth were marked with ordinal numbers from 1 to 35 with water resistant marker.

The values given by this reading represented the reference value (RV) for DD/DD pen.

After that, seven commercial dental prophylactic pastes were selected to be analyzed by DD/DD pen devices. On a glass mixing pad small amounts of different pastes were prepared (surface layer was not used), placed separately, so that they were divided from one another. Each paste was analyzed by DD/DD pen so that the tip was leaned against the middle part of a paste, and for every paste five measurements were carried out. Between measurements, DD/DD pen tips were cleaned with 70% ethanol.

Healthy molars were cleaned with particular pastes with slow speed contra angle without cooling in dental unit Sirona C8+ (Sirona Dental Systems GmbH, Bensheim, Germany) and with bristle brush No. 9645 (Komet Brasseler, Lemgo, Germany) for 10 seconds. Each prophylactic paste had its own bristle brush so that there would be no mixing of the remnants of different pastes on the brushes. This was followed by cleaning of the teeth with different methods and different duration, as described in Table 1. For different cleaning methods of the teeth from pastes, 3 in 1 syringe in dental unit Sirona C8+, which is a combination of water, air and spray, was used. The distance of the 3 in 1 syringe from the tooth surface was 2 mm. After the phase of rinsing the paste remnants, teeth were dried with air from the 3 in 1 syringe for 2 seconds. The analysis of the fissure was carried out by DD/DD pen devices and the highest value measured for each tooth was noted down.

After every cleaning with a different paste and reading of the values from DD/DD pen, it was nec-

Tablica 1. Profilaktičke paste i vrijeme čišćenja
Table 1 Prophylactic pastes and cleaning time

	Dentsply Nupro Medium	Voco Klint	Vivadent Proxyt RDA 7	Vivadent Proxyt RDA 83	Vivadent Proxyt RDA 36	Dentsply Zircate Prophy	Septodont Detartrine
Čišćenje s pastom • Cleaning with paste	10s	10s	10s	10s	10s	10s	10s
Ispiranje s vodom • Rinsing with water	5s	5s	5s	5s	5s	5s	5s
Mjerenje sa DD/DD pen • Measuring DD/DD pen**							
Čišćenje s pastom • Cleaning with paste	10s	10s	10s	10s	10s	10s	10s
Ispiranje s vodom • Rinsing with water	10s	10s	10s	10s	10s	10s	10s
Mjerenje sa DD/DD pen • Measuring DD/DD pen**							
Čišćenje s pastom • Cleaning with paste	10s	10s	10s	10s	10s	10s	10s
Ispiranje s voda+zrak sprej • Rinsing with water+air spray	5s	5s	5s	5s	5s	5s	5s
Mjerenje sa DD/DD pen • Mesuring DD/DD pen**							
Čišćenje s pastom • Cleaning with paste	10s	10s	10s	10s	10s	10s	10s
Ispiranje s voda+zrak sprej • Rinsing with water+air spray	10s	10s	10s	10s	10s	10s	10s
Mjerenje sa DD/DD pen • Measuring DD/DD pen**							

*nakon svakog mjerenja, zub je očišćen od paste i izmjerene su referentne vrijednosti(RF) • after each cleaning, the teeth were cleaned from paste and reference values were measured(RF)

trebno očistiti fisuru zuba od ostataka paste novom nekorištenom četkicom No.9654 (Komet Brasseler, Lemgo, Njemačka), zatim na mikromotoru s vodenim hlađenjem posušiti dvije sekunde pusterom te ponovno očitati referentne vrijednosti DD/DD pen-uređajima, kako ostaci paste ne bi utjecali na nova mjerenja. Zubi su nakon toga pohranjeni u fiziološku otopinu do sljedećeg ispitivanja profilaktičkih pasta, kako ne bi dehidrirali. Tijekom svakog očitanja na zubima DD/DD pen-uređajima, bilo je potrebno 70-postotnim etanolom očistiti i mjerni nastavak. Nakon svakih pet očitanja, DD/DD pen-uređaji su kalibrirani.

Statistička analiza obavljena je Wilcoxonovim testom ($p < 0,05$) Korišten je i Wilcoxonov test rangiranih predznaka ($p< 0,05$).

Rezultati

Tablica 2. prikazuje DD/DD pen-vrijednosti za različite profilaktičke paste. Najveću vrijednost - 99, imale su paste Dentsply Nupro Medium i Voco Klint, a najmanju – 2,6 Vivadent Proxyt RDA 36.

Profilaktičko čišćenje fisurnog sustava zuba pojedinim pastama i njihovo uklanjanje različitim tehnikama ispiranja, opisani su u tablici 3. Kako se vidi, Wilcoxonov test pokazuje da su sva povećanja vrijednosti nakon aplikacije pasta statistički znatna, no iz tablice je jasno da samo pasta Dentsply Nupro

essary to clean the fissure of a tooth from the paste residues with new unused bristle brush No.9654 (Komet Brasseler, Lemgo, Germany) on contra angle with water cooling, to dry it for 2 seconds with 3 in 1 syringe and to measure the reference values with DD/DD pen devices so that paste residues would not interfere with new measurements. Teeth were then stored in physiological solution until the next testing of prophylactic pastes, so they would not dehydrate. Also, by every reading with DD/DD pen it was necessary to clean the measuring DD/DD pen tip with 70% ethanol. After every five readings, DD/DD pen devices were calibrated.

The statistical analysis was carried out by Wilcoxon test ($p<0,05$). The Wilcoxon signed rank test ($p<0,05$) was also used.

Results

Table 2 shows DIAGNOdent/DIAGNOdent pen values for different prophylactic pastes. The highest value of 99 has paste Dentsply Nupro Medium and Voco Klint, and the lowest value of 2.6 has paste Vivadent Proxyt RDA 36.

Prophylactic cleaning of the fissure system of teeth with certain pastes and their removal with different rinsing techniques are described in table 3. As shown in table 3, the Wilcoxon test shows that all of the increased values after the application of a pro-

Tablica 2. DD/DD pen vrijednosti za profilaktičke paste
Table 2 DD/DD pen data for prophylactic pastes

	DIAGNOdent	DIAGNOdent pen
DentsplyNupro Medium	99.00/0.000*	99.00/0.000*
Voco Klint	99.00/0.000*	99.00/0.000*
Vivadent Proxyt RDA 7	8.60/1.342*	8.20/0.837*
Vivadent Proxyt RDA 83	4.20/0.837*	4.20/0.447*
Vivadent Proxyt RDA 36	3.60/0.548*	2.60/0.548*
Dentsply Zircate Prophy	18.40/1.187*	22.80/1.789*
Septodont Detartrine	6.80/0.447*	6.40/0.548*

*standardna devijacija • standard deviation

Tablica 3. Utjecaj metoda čišćenja i različitih pasta na DD vrijednosti
Table 3 Influence of cleaning methods and different pastes on DD readings

	DIAGNOdent mjerenja • DIAGNOdent measurements					
Pasta • Paste		**Referentna vrijednost DD • Reference value DD**	**Voda 5s DD • Water 5s DD**	**Voda 10s DD • Water 10s DD**	**Voda+zrak 5s DD • Water+air 5s DD**	**Voda+zrak 10s DD • Water+air 10s DD**
Dentsply Nupro Medium	Prosjek • Mean (SD)	3,80(1,431)	10,11(9,222)a,b	8,14(6,132)a,c,d	9,91(5,049)c,e	12,74(7,520)b,d,e
Voco Klint	Prosjek • Mean (SD)	3,80(1,431)	5,23(2,263)f,g	5,20(2,298)h,i	4,80(2,247)f,h	4,66(2,127)g,i
Vivadent Proxyt RDA7	Prosjek • Mean (SD)	3,80(1,431)	5,86(2,534)j,k,l	5,09(2,201)j,m,n	4,40(2,032)k,m	4,40(1,897)l,n
Vivadent Proxyt RDA 83	Prosjek • Mean (SD)	3,80(1,431)	5,43(2,279)o	4,97(2,176)o	5,14(2,130)	5,14(2,060)
Vivadent Proxyt RDA 36	Prosjek • Mean (SD)	3,80(1,431)	4,60(1,666)	4,80(2,125)p	4,43(1,703)	4,43(1,989)p
Dentsply Zircate Prophy	Prosjek Mean (SD)	3,80(1,431)	6,26(3,913)r,s	5,06(2,461)t,u	4,54(1,990)r,t,v	4,26(1,837)s,u,v
Septodont Detartrine	Prosjek Mean (SD)	3,80(1,431)	5,71(2,177)w,x,q	5,14(1,927)w,z,y	4,63(1,734)x,z	4,60(1,701)q,y

Napomena • Note:
Ista slova pokazuju statistički značajne razlike u očitanjima nakon različitih načina čišćenja (p<0,05). SD-standardna devijacija. • The same letters show statistical difference between readings after different cleaning methods (p<0,05). SD-standard deviation.

Medium utječe na vrijednosti tako da su statistički moguće pogrešne dijagnoze (p< 0,05) u kliničkom radu. Kako se ističe u tablici 3, Dentsply Nupro Medium tijekom svih tehnika ispiranja povećava vrijednost očitanja DD/DD pen-uređaja za oko 6 do 10 mjernih jedinica. Druge paste pokazuju porast za 1 do 2 DD/DD pen mjernih jedinica.

Tablica 4 ističe razlike između različitih profilaktičkih pasta i načina njihova uklanjanja iz fisure za DD uređaje. Kolmogorov-Smirnovljev test je pokazao da varijable nisu normalno distribuirane, pa smo rabili neparametarski Wilcoxonov test

phylactic paste are statistically significant, the table shows that only Dentsply Nupro Medium paste affects the measured values so that there is a possibility of statistically false diagnose (p<0,05) in clinical work. table 3 shows that Dentsply Nupro Medium paste increases the reading value of DD/DD pen devices approximately for 6 to 10 measure units at all cleaning methods. Other pastes show the rise for approximately 1 to 2 DD/DD pen measure units.

Table 4 shows differences among different prophylactic pastes and cleaning methods from the fissure for DD devices. Kolmogorov-Smirnov test has

Tablica 4. Utjecaj metoda čišćenja i različitih pasta na DD pen-vrijednosti
Table 4 Influence of cleaning methods and different pastes on DD pen readings

	DIAGNOdent pen mjerenja • DIAGNOdent pen measurements					
Pasta • Paste		**Referentna vrijednost DD pen • Reference value DD pen**	**Voda 5s DD pen • Water 5s DD pen**	**Voda 10s DD pen • Water 10s DD pen**	**Voda+zrak 5s DD pen • Water+air 5s DD pen**	**Voda+zrak 10s DD pen • Water+air 10s DD pen**
Dentsply Nupro Medium	Prosjek • Mean (SD)	3,69(1,471)	10,89(9,887)a,b	9,17(6,715)a,c,d	10,54(5,721)c,e	13,40(8,647)b,d,e
Voco Klint	Prosjek • Mean (SD)	3,69(1,471)	5,09(2,490)f	5,14(2,390)g,h	4,80(2,374)f,g,i	4,69(2,323)h,i
Vivadent Proxyt RDA7	Prosjek • Mean (SD)	3,69(1,471)	5,11(2,483)j,k	4,89(2,576)l,m	4,37(2,353)j,l	4,40(2,278)k,m
Vivadent Proxyt RDA 83	Prosjek • Mean (SD)	3,69(1,471)	5,69(2,720)n,o,p	4,89(2,180)n	5,17(2,320)o	5,11(2,193)p
Vivadent Proxyt RDA 36	Prosjek • Mean (SD)	3,69(1,471)	4,09(1,853)r	4,60(2,186)r,s	4,29(1,949)s	4,37(2,237)
Dentsply Zircate Prophy	Prosjek • Mean (SD)	3,69(1,471)	5,74(3,346)t,u	5,00(2,701)v,z	4,37(2,030)t,v	4,26(1,961)u,z
Septodont Detartrine	Prosjek • Mean (SD)	3,69(1,471)	5,71(2,359)q,x,y	5,23(2,263)q,w	4,91(2,174)x,w,aa	4,71(2,037)y,aa

Napomena • Note: Ista slova pokazuju statistički znatne razlike u očitanjima nakon različitih načina čišćenja (p<0,05).
SD-standardna devijacija. • The same letters show statistical difference between readings after different cleaning methods (p<0,05).
SD-standard deviation.

rangiranih predznaka za svaku pastu posebno. Taj je test pokazao da postoje statistički znatne razlike u očitanju između referentnih vrijednosti (RV) i ispiranja vodom 5 sekundi za uređaje DD i DD pen (p=0,034). U očitanju ostalih vrijednosti nije bilo statistički znatne razlike između DD i DD pen-uređaja (p>0,05)

Rasprava

DD/DD pen su uređaji za dijagnostiku koji se koriste laserskom zrakom od 655 nm, koju zatim apsorbiraju metaboliti oralnih bakterija te se reemitira kao fluorescencija (13). Osim bakterija u karijesnoj leziji, fluorescenciju mogu uzrokovati i druge tvari, kao što su plak, kamenac i različiti pigmenti. Proizvođač preporučuje temeljito čišćenje fisura od tih ostataka, kako ne bi interferirali s DD/DD pen-vrijednostima. Standardni način čišćenja fisure uključuje četkicu ili gumicu na koljičniku ili uz pomoć profilaktičke zračne abrazije na mikromotoru. Mogući su i problemi ako profilaktičke paste sadržavaju materijale koji imaju sposobnost fluorescen-

shown that variables were not normally distributed so we used nonparametric test - the Wilcoxon signed rank test which was carried out for each paste separately. The Wilcoxon test showed statistically significant differences in readings between reference values (RV) and rinsing with water for 5s for DD/DD pen (p=0,034). At readings of other values there were no statistically significant differences between DD and DD pen devices (p>0,05).

Discussion

DD/DD pen are devices for diagnostics that use a laser light of 655 nm, which is then absorbed by metabolites of oral bacteria and re-emitted as fluorescence (13). Besides bacteria in caries flora, fluorescence can be induced by other agents, such as plaque, calculus and different stains. The producer recommends thorough cleaning of the fissures from these remnants so they would not interfere with DD/DD pen readings. Standard way of fissure cleaning involves bristle brush or pumice on a contra angle or with powder in air driven systems. Possible problems may occur if prophylactic pastes contain materials with the ability of fluorescence when excitated

cije kada su ekscitirani laserskom zrakom 655 nm koja se rabi u DD/DD pen-uređajima. Anatomija fisurnog sustava također je vrlo složena i omogućuje zadržavanje ostataka profilaktičkih pasta u fisurama te moguću interferenciju s DD/DD pen-očitanjima. To sve može rezultirati povećanjem DD/DD pen - vrijednosti i pogrešnom interpretacijom stanja fisurnog sustava, pa zbog toga i pogrešnom terapijom.

Prema našim istraživanjima, paste Dentsply Nupro Medium i Voco Klint pokazuju vrijednost DD/DD pen-očitanja od 99. Ali, samo pasta Dentsply Nupro Medium ima statističi znatno povećanje vrijednosti od 4,34 do 8,94 za DD uređaj te od 5,48 do 9,71 za DD pen-uređaj. Ta povećanja mogu rezultirati u kliničkom radu s DD i DD pen-uređajima očitanjem pogrešnih vrijednosti samih uređaja, pa tako i pogrešnom terapijom. Pasta Voco Klint, bez obzira na njezinu početnu vrijednost od 99, pokazuje povećanje od 0,86 do 1,43 za DD uređaj te od 1 do 1,45 za DD pen-uređaj. To se može objasniti razlikama u konzistenciji pasta, veličini granula te ostalim fizikalnim svojstvima materijala koji utječu na čišćenje ostataka paste iz fisure i njezinu manju adherenciju u fisurama. Ostale paste nisu imale statistički znatno povećanje DD/DD pen-vrijednosti te ne utječu na klinički rad tako da bi se mogle očitati pogrešne DD/DD pen-vrijednosti i izabrala pogrešna terapija.

U svojem su radu Hosoya i suradnici (14) dokazali statistički znatno povećanje DD vrijednosti kod profilaktičke paste Pressage without Fluoride - u iznosu od 17,5 DD jedinica, što može utjecati na klinički rad. Autori sugeriraju da se izbjegavaju paste koje sadržavaju plavac tijekom čišćenja fisura, radi analize DD uređajem zbog njegove velike fluorescentne vrijednosti. Osim toga, paste za poliranje zuba s visokim fluorescentnim vrijednostima ostaju u dubokim i uskim fisurama, unatoč dodatnom čišćenju rotirajućom četkicom i vodom te njihovi ostaci interferiraju s DD vrijednostima.

Lussi i suradnici (15) dokazali su statistički znatno povećanje DD vrijednosti kod paste Clinic, i to za 0,7 jedinica, ali to ne utječe na kliničke rezultate. Autori također ističu da ljepljivost različitih pasta za profilaksu i čišćenje te njihova fluorescencija imaju velik utjecaj na očitanje DD uređaja. Naime, osim anatomije fisura koje predstavljaju retencijsko mjesto za paste, i makroskopski zdravo zubno tkivo može sadržavati mikrokavitete koji mogu retinirati pastu. Studija je pokazala i to da većina profilaktičkih pasta, pasta za zube i praškova za abrazivno profilaktičko čišćenje ne interferira s DD vrijednostima,

with the 655 nm laser light used in DD/DD pen devices. Also, the complex anatomy of the fissure system enables retention of prophylactic paste residues in the fissures and possible interference with DD/DD pen readings. This all can result in increased DD/DD pen values and can bring to false interpretation of the state of fissure system which then results in false therapy.

According to our study, prophylactic pastes Dentsply Nupro Medium and Voco Klint show DD/DD pen reading value of 99. But only the paste Dentsply Nupro Medium shows statistically significant increase of DD device reading value for 4.34 to 8.94 and for 5.48 to 9.71 for DD pen. These increased values can bring to false interpretations in clinical work with DD and DD pen devices, and to false therapy. The paste Voco Klint regardless of its initial value of 99, shows increase of value for 0.86 to 1.43 for DD device, and for 1 to 1.45 for DD pen. These results can be explained with differences in paste consistence, paste particles and other physical properties of the materials which influence cleaning of the paste residues from a fissure and its reduced adherence in the fissures. Other pastes did not show statistically significant DD/DD pen value increase, and have no influence on clinical work in way that they would lead to false DD/DD pen readings and false therapy.

In their work Hosoya et al. (14) have proved statistically significant increase of DD value for prophylactic paste Pressage without Fluoride in 17.5 DD measure units, which can have an influence on clinical work. The authors suggest avoiding pastes that contain pumice when cleaning the fissures for the analysis with DD device, because of its great fluorescent value. Also, polishing pastes retain in deep and narrow fissures even with additional cleaning with rotating bristle brush and water, and their residues interfere with the DD values.

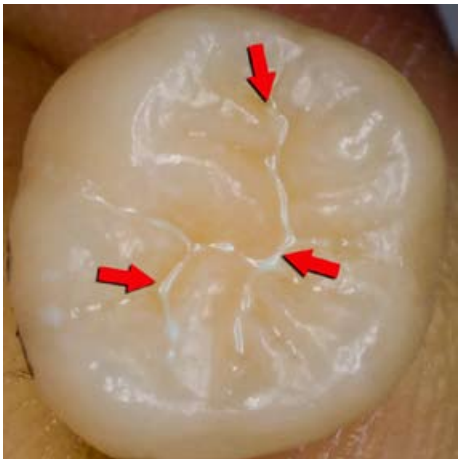
Lussi et al. (15) have shown statistically significant DD value increase for paste Clinic for 0.7 units, but this increase does not interfere with clinical results. The authors are also stressing upon stickness of different prophylactic pastes and toothpastes and their fluorescence which has a great impact on DD readings. Namely, besides the anatomy of fissures which is the retention spot for pastes, a macroscopic sound tooth tissue can contain microcavities that can retain paste. The study has also shown that a majority of prophylactic pastes, toothpastes and air driven polishing powders do not interfere with DD values if the residues are cleaned for 3s with 3 in 1 syringe. Mod-

ako se ostaci dobro isperu tri sekunde sprejem zraka i vode. Moderna dijagnostika karijesa DIAGNOdent-uređajima mora uzeti u obzir različite čimbenike koji utječu na očitanje DIAGNOdent-vrijednosti, jer oni mogu utjecati na izbor terapije zuba.

Istraživanje je pokazalo velike varijacije između načina i vremena ispiranja ostataka paste iz fisura zuba te nije utvrđena najbolja metoda za taj postupak. Naša pretpostavka je bila da će od četiriju načina otklanjanja ostataka paste iz fisure, ispiranje sprejem vode i zraka 10 sekudi pokazati najbolje rezultate, ali to nije dokazano u ovom radu. Slika 2. pokazuje ostake paste Vivadent Proxyt RDA 36, nakon ispiranja vodom 10 sekundi.

ern diagnostics of caries with DIAGNOdent devices must take into consideration different factors which interfere with DIAGNOdent readings because these factors can influence selection of the tooth therapy.

The research has shown great variations between methods and time of cleaning the residues of pastes from the teeth fissures, and the best method for that procedure was not established. Our assumption was that from four cleaning methods of the fissures from the paste residues, cleaning with spray of water for 10 s will show the best results, but that was not proven by this study. Figure 2 shows the residues of Vivadent Proxyt RDA 36 paste after cleaning with water for 10s.



Slika 2. Ostaci paste Vivadent Proxyt RDA 36 u fisuri nakon ispiranja vodom 10s.
Figure 2 The remains of Vivadent Proxyt RDA 36 paste after 10s rinsing with water

Lussi i suradnici (25) dokazali su da nema razlike u očitanju DD vrijednosti na vlažnom zubu i na zubu kratko posušenom zrakom. Autori također ističu da mnogi depoziti, kao što su plak i kamenac u fisuri, mogu dati lažno pozitivne nalaze, pa se zaključuje da je potrebno dobro čišćenje fisura od takvih depozita. Ostali autori također ističu povećanje vrijednosti DD uređaja zbog plaka, što može rezultirati lažno pozitivnim vrijednostima (10,23).

Mendes i suradnici (11) zabilježili su smanjenje DD vrijednosti u plaku. Prema njihovu mišljenju, plak djeluje kao zapreka laserskim zrakama iz DD uređaja. Zaključili su da nema razlike u DD očitanjima na vlažnim zubima, sušenima zrakom tri sekunde i sušenima zrakom 15 sekundi. Razlika je samo kod dehidriranih zuba. Zbog razlika u očitanju DD vrijednosti kod vlažnih i suhih zuba, autori preporučuju normiziranje profilaktičkih metoda i vremena sušenja zuba tijekom korištenja DD uređaja.

Antonnen i suradnici (26) također su potvrdili da neočišćeni zubi imaju manje DD vrijednosti od zuba profilaktički čišćenih, ali ipak sugeriraju čišće-

Lussi et al. (25) have proven that there is no difference in reading DD values on moist tooth and on tooth that was briefly air-dried by 3 in 1 syringe. The authors are pointing out that different deposit, such as plaque and calculus in the fissure, can give false-positive readings which leads to conclusion that thorough cleaning of fissures from such deposits is necessary. Other authors also point out the increased values of DD device when plaque is present which can lead to false positive values (10, 23).

Mendes et al. (11) have noted a decrease of the DD values in plaque presence. According to their opinion, plaque works as barrier towards the laser ray from the DD device. They concluded that there is no difference in DD readings on moist teeth, teeth dried with air for 3 s or dried with air for 15 s. There is only a difference when teeth are dehydrated. Because of distinction in readings of the DD values of moist and dried teeth, the authors recommend standardization of prophylactic methods and time of drying of the teeth when using the DD devices.

nje zuba s vidljivim plakom rotirajućim instrumentima i vodenim sprejem.

Shi i suradnici (9) dokazali su da postoji razlika u DD očitanjima na vlažnim zubima i zubima sušenima zrakom dvije minute – vrijednosti su više za suhe zube. Osim toga potrebno je dobro očistiti površinu zuba, jer je uređaj vrlo osjetljiv na kamenac, različite depozite i egzogena obojenja.

Lussi i suradnici (27) zaključuju da okluzalne plohe moraju biti čiste i suhe kako bi se precizno longitudinalno izmjerio karijes DD uređajem i obavila vizualna inspekcija prije DD mjerenja. Ako su plohe zuba čiste, tada na dijagnostičke sposobnosti DD uređaja ne utječu ni vlažne ni suhe površine.

Iako su istraživanja dokazala mnogobrojne prednosti DD/DD pen-uređaja tijekom analize karijesa, tehnika laserske fluorescencije koja se koristi kod DD/DD pen uređaja vrlo je osjetljiva te je potreban velik oprez i iskustvo u rukovanju i svakodnevnom radu, kako se ne bi dogodile pogrešne interpretacije rezultata i pogrešne terapije.

Zaključci

1. neke profilaktičke paste znatno utječu na povećanje vrijednosti fluorescencije kod DIAGNOdent i DIAGNOdent pen-uređaja, pa bi ih trebalo izbjegavati;
2. nije utvrđen najbolji način uklanjanja ostataka profilaktičke paste iz fisura;
3. potrebna su dodatna fizikalna i ostala ispitivanja različitih pasta i načina čišćenja fisura da se odredi najbolji način koji bi postao standardni postupak u kliničkom rada s DIAGNOdent/DIAGNOdent pen-uređajima.

Zahvale

Autori zahvaljuju tvrtki Sanitaria d.o.o. Zagreb na ustupljenom DIAGNOdent uređaju za potrebe ovog rada. Projekt Ministarstva znanosti, obrazovanja i športa: 065-0653147-2056 "Prevencija ranog karijesa kod djece: evaluacija kliničkih i preventivnih postupaka"

Antonen et al. (26) also confirmed that uncleaned teeth show lower DD values than teeth that are prophylacticly cleaned, but anyhow they suggest cleaning of the teeth with visible plaque with rotating instruments and water spray.

Shi et al. (9) have proven that there is a difference in DD readings on moist teeth and on teeth dried with air for 2 minutes, resulting in higher values for dried teeth. Besides, it is necessary to clean the surface of the teeth because the device is very sensitive on presence of calculus, various deposits and egzogenic colorations.

Lussi et al. (27) are concluding that occlusal surfaces must be clean and dry for precise longitudinal measurement of caries with the DD device, as well as by visual inspection which precedes the DD measurement. If surfaces are clean, the diagnostic abilities of DD device are not affected by moist or dry surfaces.

Although the researches have shown numerous advantages of DD/DD pen devices for caries analysis, the technique of laser fluorescence used by DD/DD pen devices is extremely sensitive and great attention and experience are needed for everyday work so that there would be no false interpretations of the results and there would be no false therapy.

Conclusions

1. Some prophylactic pastes considerably influence increase of the fluorescence values of DIAGNOdent and DIAGNOdent pen devices, so they should be avoided.
2. No preferable method of cleaning the residues of prophylactic pastes from the fissures was established.
3. There is a need for further physical and other testings of different pastes and methods of the fissure cleaning to establish the best method which will become the standard procedure in clinical work with DIAGNOdent/DIAGNOdent pen devices.

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Project of Ministry of Science, Education and Sports: 065-0653147-2056 "Prevention of early caries in children: clinical evaluation of preventive methods".

Abstract
Aim: The aim of this study is to analyze the influence of different prophylactic pastes on DIAGNOdent/DIAGNOdent pen (DD/DD pen) readings and the influence of different times and cleaning methods of the prophylactic pastes residues on DD/DD pen reading values. Also, it had to be established if there were differences in readings between DD and DD pen device. **Material and Methods:** On 35 healthy permanent third molars reference values were measured with DD/DD pen devices and only teeth whose values did not exceed the value of 5 were selected. The research included seven different prophylactic pastes (DentsplyNupro Medium, Voco Klint, Vivadent Proxyt RDA 7, Vivadent Proxyt RDA 83, Vivadent Proxyt RDA 36, Dentsply Zircate Prophy, Septodont Detartrine) and their influence on DD/DD pen reference values. Also, four different cleaning methods of paste from the fissures were examined: water for 5s, water for 10s, water+air for 5s and water+air for 10s. **Results:** The paste Dentsply Nupro shows statistically significant increase of values for 4.34 to 8.94 for DD device, and for 5.48 to 9.71 for DD pen device ($p<0,05$), other pastes did not show any significant increase of values. **Conclusion:** The statistical difference in cleaning methods of prophylactic paste residues from the fissures was not proven. After usage of any of the cleaning methods, small amounts of paste stay in fissure and influence the DD/DD pen values. There are statistically significant differences between reference values and cleaning method with water for 5s for the DD and DD pen devices ($p=0,034$). When reading the other values, no statistically significant differences were shown between DD and DD pen devices ($p>0,05$).

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Toothpaste; Toothbrushing; Oral Hygiene

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